

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Previously Presented) A surface finishing apparatus for surface finishing a target shaped periphery of a workpiece into a mid-concave profile, comprising:
 - a workpiece supporting mechanism for supporting the workpiece having the target shaped periphery to be surface finished;
 - a surface finish tool including a lapping film adapted to be in abutting contact with the target shaped periphery of the workpiece;
 - a pressure applying mechanism including a plurality of shoes disposed on a rear side of the lapping film to be operative to apply a pressure force to the lapping film to cause the lapping film to be held in pressured contact with the target shaped periphery of the workpiece;
 - a drive mechanism for rotating the workpiece about an axial direction during operation of the pressure applying mechanism to allow the surface finish tool to surface finish the target shaped periphery of the workpiece into the mid-concave profile, while exhibiting a distribution pattern of the pressure force of the surface finish tool; and
 - an oscillating mechanism for oscillating at least one of the workpiece and the lapping film in the axial direction of the workpiece in a given oscillation stroke such that a working position of the lapping film is cyclically shifted in the given oscillation stroke with respect to the target shaped periphery of the workpiece to allow the workpiece to be surface finished in the mid-concave profile,
- wherein the pressure applying mechanism is adapted to operatively hold the plurality of shoes on the rear side of the lapping film in different contact areas in a partially overlapping relationship at a central region of the target shaped periphery of the workpiece and in non-overlapping relationship in both terminal regions of the target shaped periphery such that the plurality of shoes are held in opposing offset positions with offset displacement of each of the plurality of shoes set to be less than the given oscillation stroke provided by the oscillating mechanism to allow the central region of the target shaped periphery to be lapped at a greater rate than those at which other regions of the target shaped periphery are lapped,

resulting in the target shaped periphery having a surface profile formed in the mid-concave profile having a depth equal to or greater than 5 μm and equal to or less than 20 μm .

2. (Canceled)

3. (Previously Presented) The surface finishing apparatus according to claim 1, wherein:

the lapping film includes a thin-walled base member having an entire surface provided with abrasive material with an abrasive surface of the thin-walled base member; and

the plurality of shoes allows the abrasive surface of the lapping film to be held in contact with the target shaped periphery to be lapped.

4. (Previously Presented) The surface finishing apparatus according to claim 3, wherein the pressure applying mechanism includes a tool holder that operatively holds the plurality of shoes on the rear side of the lapping film.

5. (Canceled)

6. (Previously Presented) The surface finishing apparatus according to claim 1, wherein the plurality of shoes include an even number of shoes with a same width and the even number of shoes are alternately offset at different sides with respect to a center of the target shaped periphery to be lapped.

7. (Previously Presented) The surface finishing apparatus according to claim 1, wherein an amount of offset displacement between the plurality of shoes falls in a value ranging from 3 to 12 % of the given width of the target shaped periphery to be lapped.

8. (Canceled)

9. (Previously Presented) The surface finishing apparatus according to claim 3, wherein the workpiece includes a crankshaft having a journal portion or a pin portion each having the target shaped periphery, on both ends of which fillet portions are formed.

10. (Previously Presented) The surface finishing apparatus according to claim 3, wherein the lapping film includes the thin-walled base member, the thin-walled base member being non-extensible and deformable.

11. (Withdrawn) The surface finishing apparatus according to claim 4, wherein the tool holder further includes a shoe pressure force adjusting unit operative to adjust the shoe pressure force to be applied to the plurality of shoes.

12. (Withdrawn) The surface finishing apparatus according to claim 11, wherein:
a tool shifting mechanism includes the oscillating mechanism oscillating at least one of the workpiece and the lapping film with respect to one another in the axial direction of the workpiece; the apparatus further comprising:

a detecting unit detecting a relative oscillating position of the workpiece with respect to the lapping film during oscillating movement performed by the oscillating mechanism to be indicative of a current relative oscillating movement of the workpiece; and

a controller variably controlling the pressure force adjusting unit to vary the shoe pressure force in response to the current relative oscillating movement of the workpiece such that the lapping film is held in contact with the target shaped periphery of the workpiece to lap the target shaped periphery into the given geometrical profile.

13. (Withdrawn) The surface finishing apparatus according to claim 12, wherein the controller controls operation of the pressure force adjusting unit such that the pressure force occurring when the oscillating position of the workpiece assumes both terminal portions of the oscillating stroke of the workpiece during the oscillating movement thereof becomes greater than that occurring when the oscillating position of the workpiece assumes a central position on the oscillating stroke of the workpiece during the oscillating movement thereof, whereby the given geometrical profile is formed into at least one of a flat shape and the mid-convex shape.

14. (Withdrawn) The surface finishing apparatus according to claim 12, wherein the controller controls operation of the pressure force adjusting unit such that the pressure force occurring when the oscillating position of the workpiece assumes both terminal portions

of the oscillating stroke of the workpiece during the oscillating movement thereof becomes smaller than that occurring when the oscillating position of the workpiece assumes a central position on the oscillating stroke of the workpiece during the oscillating movement thereof, whereby the given geometrical profile is formed into the mid-concave shape.

15. (Withdrawn) The surface finishing apparatus according to claim 13, wherein the controller controls the operation of the pressure force adjusting unit such that a change rate, between the pressure force occurring when the oscillating position of the workpiece assumes the both terminal portions of the oscillating stroke of the workpiece during the oscillating movement thereof and the pressure force occurring when the oscillating position of the workpiece assumes the central position on the oscillating stroke of the workpiece during the oscillating movement thereof, required for forming the geometrical profile into the mid-convex shape, is set to be greater than that required for forming the geometrical profile into the flat shape.

16. (Withdrawn) The surface finishing apparatus according to claim 3, wherein the pressure applying mechanism includes first and second presser arms pivotally supported to be moved in an open position and a closing position, first and second shoe cases slidably carried by the first and second presser arms and disposed on the rear side of the lapping film held in contact with the target shaped periphery of the workpiece, and first and second pressure force adjusting units cooperating with the first and second shoe cases, respectively, to apply adjustable shoe pressure forces to respective first and second shoes.

17. (Withdrawn) The surface finishing apparatus according to claim 16, wherein the first and second pressure force adjusting units includes first and second lift adjustment elements operatively connected to the first and second shoe cases through first and second presser rods, respectively, and first and second actuators connected to the first and second lift adjustment elements, respectively, to vary angular working positions of the first and second lift adjustment elements with respect to the first and second presser rods, respectively, for thereby varying the shoe pressure forces to be applied to the first and second shoes, respectively.

18. (Withdrawn) The surface finishing apparatus according to claim 1, wherein:
the workpiece has the target shaped periphery with the geometrical profile, lapped in
the mid-concave shape;

a tool holder is connected to the pressure applying mechanism and includes a tool
support; and

the surface finish tool includes a burnishing roller supported by the tool support in
pressured contact with the target shaped periphery of the workpiece for thereby burnishing
terminal convex portions of the target shaped periphery in given surface roughness.

19. (Withdrawn) The surface finishing apparatus according to claim 18, wherein
the burnishing roller is operative to flatten sharp edges on both the terminal convex portions
of the target shaped periphery.

20. (Withdrawn) The surface finishing apparatus according to claim 19, wherein
the target shaped periphery of the workpiece includes a journal portion or a pin portion of a
crankshaft formed with fillet portions on both ends of the target shaped periphery.

21. (Cancelled)

22. (Cancelled)

23. (Withdrawn) The surface finishing apparatus according to claim 22, wherein:
the rocking mechanism includes a pair of pinch members operatively connected to the
one end of the tool holder, a pair of support members supporting the pair of pinch members,
respectively, and a rocking source supported by the pressure applying mechanism and
connected to the support members to rock the tool holder; and

an amount of rocking movement is controlled to enable a rocking angle of the support
members to be controlled.

24. (Withdrawn) The surface finishing apparatus according to claim 23, wherein
the rocking source includes a piston/cylinder mechanism.

25. (Cancelled)

26. (Previously Presented) A surface finishing apparatus for surface finishing a target shaped periphery of a workpiece into a mid-concave profile, comprising:

workpiece supporting means for supporting the workpiece having the target shaped periphery to be surface finished;

a surface finish tool including a lapping film adapted to be in abutting contact with the target shaped periphery of the workpiece;

pressure applying means for applying a pressure force to the lapping film to cause the lapping film to be held in pressured contact with the target shaped periphery of the workpiece;

rotating means for rotating the workpiece about an axial direction during operation of the pressure applying means to allow the surface finish tool to surface finish the target shaped periphery of the workpiece into the mid-concave profile, while exhibiting a distribution pattern of the pressure force of the surface finish tool; and

oscillating means for oscillating at least one of the workpiece and the lapping film in the axial direction of the workpiece in a given oscillation stroke such that a working position of the lapping film is cyclically shifted in the given oscillation stroke with respect to the target shaped periphery of the workpiece to allow the workpiece to be surface finished in the mid-concave profile,

wherein the pressure applying means is adapted to operatively apply pressure on a rear side of the lapping film in different contact areas in a partially overlapping relationship at a central region of the target shaped periphery of the workpiece and in non-overlapping relationship in both terminal regions of the target shaped periphery such that the portions of the pressure applying means disposed on the rear side of the lapping film are held in opposing offset positions with offset displacement of each of the portions of the pressure applying means disposed on the rear side of the lapping film set to be less than the given oscillation stroke provided by the oscillating means to allow the central region of the target shaped periphery to be lapped at a greater rate than those at which other regions of the target shaped periphery are lapped, resulting in the target shaped periphery having a surface profile formed in the mid-concave profile having a depth equal to or greater than 5 μm and equal to or less than 20 μm .

27. (Previously Presented) A method of surface finishing a target shaped periphery of a workpiece into a mid-concave profile, the method comprising:

- supporting the workpiece having the target shaped periphery to be surface finished;
- holding a surface finish tool including a lapping film in abutting contact with the target shaped periphery of the workpiece;
- disposing a plurality of shoes on a rear side of the lapping film to apply a pressure force to the lapping film to cause the lapping film to be held in pressured contact with the target shaped periphery of the workpiece;
- rotating the workpiece about an axial direction to allow the surface finish tool to surface finish the target shaped periphery of the workpiece into the mid-concave profile, while exhibiting a distribution pattern of the pressure force of the surface finish tool; and
- oscillating at least one of the workpiece and the lapping film in the axial direction of the workpiece in a given oscillation stroke such that a working position of the lapping film is cyclically shifted in the given oscillation stroke with respect to the target shaped periphery of the workpiece to allow the workpiece to be surface finished in the mid-concave profile,

wherein the plurality of shoes are held on the rear side of the lapping film in different contact areas in a partially overlapping relationship at a central region of the target shaped periphery of the workpiece and in non-overlapping relationship in both terminal regions of the target shaped periphery such that the plurality of shoes are held in opposing offset positions with offset displacement of each of the plurality of shoes set to be less than the given oscillation stroke to allow the central region of the target shaped periphery to be lapped at a greater rate than those at which other regions of the target shaped periphery are lapped, resulting in the target shaped periphery having a surface profile formed in the mid-concave profile having a depth equal to or greater than 5 μm and equal to or less than 20 μm .